

The use of Augmented Soft Tissue Mobilization (ASTYM®) as a Conservative Treatment for Patellofemoral Pain Syndrome.

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ABSTRACT:

Background: Soft tissue mobilization can normalize the altered tensile loads and biomechanical dysfunction associated with patellofemoral pain syndrome by promoting proper tracking of the patella within the trochlear groove. Augmented Soft Tissue Mobilization (ASTYM®) is a form of instrument-assisted soft-tissue mobilization that promotes the remodeling of soft tissue through controlled tissue damage to promote tissue healing, release adhesions, and improve tissue extensibility.

Purpose: The purpose of this case description was to assess the efficacy of Augmented Soft Tissue Mobilization (ASTYM®), in accordance with standard physical therapy, for the treatment of PatelloFemoral Pain Syndrome.

Case Description: The subject was a 56 year old female referred to physical therapy with PFPS who presented with antalgic gait, mild swelling at medial and lateral patella, pain with palpation of the joint line, decreased knee range of motion, and decreased knee and hip strength.

Outcomes: At the end of the 6-week intervention, the subject presented with decreased pain, improved gait mechanics, proper squatting mechanics, improved lower extremity strength, improved knee active range of motion, improved Lower Extremity Functional Scale (LEFS) and Global Rating of Change (GRC) scores, and improved activity tolerance with standing, sitting, and walking.

Discussion: It is hypothesize that ASTYM® treatment may have contributed to decreasing the subject's knee pain. ASTYM® may have allowed increased blood flow to the treated area through microscopic capillary leakage, in order to reduce adhesions, improve extensibility, and promote healing of the soft tissue surrounding the knee. Improving the quality of these tissues may have helped to normalize the tensile forces acting on the patellofemoral joint in order to reduce anterior knee pain.

KEY WORDS: Patellofemoral pain syndrome, anterior knee pain, instrument assisted soft tissue mobilization, augmented soft tissue mobilization, ASTYM, physical therapy.

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BACKGROUND:

Patellofemoral Pain Syndrome (PFPS) is a term used to describe a variety of anatomical abnormalities that lead to anterior knee pain¹. Pain is typically described as “under” or “behind” the knee, and is present during activities that place an increased load on the patellofemoral joint (PFJ), such as ascending or descending stairs, squatting, or running². PFPS is theorized to be caused by imbalances in the forces that act on the patella, leading to patellar maltracking and overloading of the PFJ during knee motion². It is hypothesized that excess friction on the underside of the patella can eventually result in softening of the cartilage (chondromalacia patellae), cartilage breakdown, and cartilaginous lesions on the posterior patella^{2,3}.

Because PFPS is often considered a “condition of both malalignment and muscular dysfunction,” a majority of patients with PFPS are referred to physical therapy¹. Physical therapy has been shown to be one of the most successful forms of treatment for PFPS. While 66% to 87% of patients with PFPS will have successful outcomes with conservative therapy, 32% of patients with PFPS have a return in symptoms within 16 months^{1,4,5}.

Common causes of PFPS include overuse, trauma, and anatomical factors². Anatomical factors include: patellar size and shape, depth of the trochlear groove, muscle tightness, muscle weakness, ligamentous laxity, high muscle tone, patellar hypermobility, and patellar hypomobility^{1,2,4,5,6}. Although there is no agreement for a standard PT treatment regimen, a majority of treatments focus primarily on quadriceps strengthening. There has been a recent emphasis on hip strengthening, flexibility training, and neuromuscular control training for the treatment of PFPS as well^{2,7,8,9}.

One of the most commonly overlooked interventions for PFPS is the use of soft tissue mobilization^{10,11}. Because of the extensive fascial network of the tissues around the knee, soft tissue mobilization can be highly beneficial for normalizing the tensile loads and biomechanical dysfunction associated with PFPS³. Specifically, cross friction mobilization techniques have been shown to decrease retinacular stiffness at the distal end of the vastus lateralis, and the adjacent fascia of the iliotibial band¹². Iliotibial band tightness (through anatomical correlations to the lateral retinaculum) will increase the lateral force vector on the patella to increase lateral PFJ stresses¹. Soft tissue mobilization applied to the fibers of the vastus lateralis muscle, lateral retinaculum, and iliotibial band may help to release adhesions between adjacent tissues in order to increase extensibility and promote proper tracking of the patella within the trochlear groove^{3,12,13}. Research has also shown that soft tissue mobilization of the hamstrings, gastrocnemius, soleus, fibrous joint capsule, and patellar tendon can improve extensibility to reduce PFPS symptoms^{3,14}.

While there are limited studies discussing the use of soft tissue mobilization for the treatment of PFPS, there are even fewer studies describing the use of instrument assisted soft tissue mobilization (IASTM) for this condition. Augmented Soft Tissue Mobilization (ASTYM®)

utilizes 3 specially designed instruments to locate and treat soft tissue restrictions through a series of sequenced strokes^{15,16}. ASTYM® utilizes theories similar to cross friction massage, with the idea that the instruments allow the therapist to magnify the effects of treatment¹⁷. Each instrument glides parallel to tissue fibers, and catches on irregular fibroses¹⁸. ASTYM® promotes the remodeling of soft tissue after injury through controlled tissue damage, increased blood flow, and mild inflammation to create an environment to allow the tissue to remodel more normally^{16,17}. The process of ASTYM® is more gentle than some forms of IASTM, and is hypothesized to activate regeneration of tissues by inducing leakage from dysfunctional capillaries^{15,18}. These microscopic leaks lead to fibroblast activation, phagocytosis, and the release of growth factors in order to heal abnormal tissue^{16,19}. ASTYM® is always followed by stretching and strengthening exercises to provide an appropriate stimulus to the tissues so that it may remodel along the lines of stress¹⁷. ASTYM® has been described as an effective treatment for tendinopathies at the knee joint, however limited research exists regarding the use of ASTYM® for PFPS^{17,19}.

The purpose of this case description was to assess the efficacy of Augmented Soft Tissue Mobilization (ASTYM®), in conjunction with standard physical therapy interventions, for the treatment of PatelloFemoral Pain Syndrome (PFPS).

CASE DESCRIPTION:

Subject History

The subject of this case study was a 56 year old female who was referred to physical therapy by her primary physician for right knee pain. The subject felt a “pop,” and suffered a work-related injury while squatting down to retrieve an object 1 month prior to PT evaluation. She stated the pain was a 10/10 when the injury occurred, and reported she was experiencing 9/10 pain in the anterior knee during the initial PT evaluation. She described the pain as achy with occasional sharpness during weight bearing. The subject’s functional limitations included: sleeping through the night, walking, dressing, stair climbing, cleaning, cooking, laundry, recreational walking, and playing with grandchildren. These factors limited her ability to be a grandmother, cellular service technician, and independent adult. At the initial evaluation, the subject reported that her symptoms had made no significant change since the injury occurred.

The subject’s past medical history was unremarkable. MRI results indicated the subject had Grade IV chondromalacia patella at the medial patellar facet; MRI results were negative for meniscal or ligamentous involvement.

Tests and Measures

The primary outcome measures performed with this subject include: the Numeric Pain Rating Scale (NPRS) and the Lower Extremity Functional Scale (LEFS). Additionally, the Global Rating of Change (GRC) Scale was collected at 3-week re-evaluation and at discharge.

The NPRS was used to measure the subject's perceived level of pain on a scale of 0 (no pain) to 10 (worst pain imaginable). This scale has not been validated in patients with PFPS, however it has been shown to be reliable and valid for other musculoskeletal conditions of the lower extremity^{11,20}.

The Lower Extremity Functional Scale is a 20-item functional assessment tool that rates the level of difficulty of functional tasks from 0 (extremely difficult) to 4 (no difficulty)¹¹. With a maximal score of 80, a lower score indicates a greater level of perceived disability^{11,21}. The LEFS has been shown to have adequate validity to the Short Form-36 ($r=0.80$), and demonstrates high test-retest reliability (ICC=0.98) in the PFPS population^{11,21}.

The GRC is an 11-point visual scale that indicates the subject's perception of improvement¹¹. The scale varies from -5 (very much worse) to +5 (completely recovered) with 0 indicating no change¹¹. This version of the GRC has very good test-retest reliability (ICC 0.90) and is very sensitive to change²².

Other measures that were used include: visual gait assessment, goniometry, manual muscle testing, palpation, and special tests.

Observational gait assessment was utilized in this case report due to its cost-effectiveness and ease of administration. Visual assessment of the body during gait was used to determine joint mechanics and postural compensations²³. Because there is no standardized form of gait assessment, the therapists determined impairments using their own visual strategies and patterns²³.

Goniometry is recognized as a standardized method for quantifying joint motion. Goniometry has good intratester and intertester reliability when therapists are using a standardized measurement procedure; it has good test-retest reliability (ICC=0.90) and a strong intraclass correlation coefficient (ICC=0.92)^{24,26,27}. Knee AROM was measured in this subject following standardized procedures²⁵.

Strength of the subject's lower extremities was quantified using standardized manual muscle testing techniques graded on a 0-5 scale²⁸. Although a dynamometer is considered the gold standard for manual muscle testing of the lower extremity, manual muscle testing was utilized based on time constraints and clinical resources.

Palpation was performed at anterior knee, joint line, and posterior knee to determine pain provocation. For a summary of examination results, see **Table 1**.

Clinical Impressions

The subject was considered a good candidate for physical therapy because of her age, prior activity levels, and strong motivation to improve her functional abilities.

Based off of the examination findings, the subject presented with the following impairments: antalgic gait, bilateral knee valgus, mild swelling at right medial and lateral patella, pain with palpation of medial and lateral joint line, decreased right knee active range of motion, decreased quadriceps and hamstring strength bilaterally, and decreased right hip strength. She also experienced pain during closed-chain quadriceps activity such as lunging, stairs, and squatting. She presented with mild patellar maltracking and lateral patellar tilt.

The subject's objective presentation, and subjective descriptions lead the therapists to believe this subject did in fact have PFPS. It was hypothesized that the subject had a good prognosis for returning to her normal work, home care, and leisure activities within 6 weeks pending compliance with therapy interventions and home exercise program.

INTERVENTIONS:

The subject was seen 2x/week for 6 weeks. Every treatment session began with a 6 to 8 minute warm-up on a recumbent bike in order to increase tissue temperature and promote knee flexion within the subject's tolerance. The temperature changes during warm-up promote healing, increase nerve conduction velocity, and increase muscle compliance²⁹.

The warm-up was followed by 10-15 minutes of ASTYM® treatment. The ASTYM® technique was performed by a certified ASTYM® provider on the affected lower extremity. The technique consisted of repeatedly gliding hard plastic tools across the skin, applying moderate pressure as tolerated parallel to the alignment of the tissue fibers beneath. This method places less force on the therapist's hands compared to cross-friction massage, and allows deeper penetration of the affected tissue¹⁷. Cocoa butter was used as lubricant to promote a smooth glide across the skin. A broad surfaced tool was used first in order to screen for abnormal tissue, followed by the use of two progressively smaller tools that target abnormal tissue more specifically. Application started distally at the anterior ankle, and systematically moved proximally to the anterior thigh. The posterior aspect of the affected lower extremity was treated next, starting at the Achilles insertion, moving proximally to the hamstrings. For this particular subject, extra emphasis was placed on the patella, patellar tendon, quadriceps tendon, medial retinaculum, lateral retinaculum, gastroc origin, and hamstring distal insertion. The subject made significant improvements in tissue quality and pain provocation after each treatment, therefore it was decided to discontinue ASTYM® after 8 visits.

Following ASTYM® treatment, the subject was instructed to perform hamstring, gastrocnemius, and quadriceps stretching. Stretching of each muscle group was performed 3x30 seconds. Stretching of the hamstring musculature was performed in sitting and was deemed important for

this specific subject because hamstring tightness has been shown to cause slight knee flexion during activities, therefore altering the biomechanics of the knee joint¹. Additionally, this tightness in the hamstring places higher stress on the quadriceps to overcome knee flexion forces, and therefore places additional strain upon the PFJ during functional mobility¹. Gastrocnemius stretching was performed in standing with the use of a 45 degrees slantboard. Gastrocnemius and soleus tightness have been shown to reduce the amount of dorsiflexion, leading to subtalar joint pronation and tibial internal rotation¹. These factors can increase the amount of knee valgus present, and therefore produce less ideal biomechanics at the PFJ. Standing quadriceps stretching (in which the subject would pull her right heel toward the back of her thigh) was also performed every session. Research has shown that quadriceps tightness can place high stress on the patella, predisposing individuals to develop pain behind or directly above the patella¹. Quadriceps shortness has also been hypothesized to contribute to tracking abnormalities or an abnormal resting position of the patella within the trochlear groove⁸.

Stretching was followed by concentric and eccentric strengthening of the lower extremities. The primary focus for the subject was closed-chain quadriceps strengthening. Quadriceps weakness (specifically the vastus medialis obliquus in comparison to the vastus lateralis) can lead to lateral displacement of the patella³⁰. In addition, a weak vastus medialis obliquus cannot adequately support the medial patella during quadriceps activation, and therefore can lead to improper patellar alignment and patellar maltracking¹. Interventions utilized to improve quadriceps weakness include the leg press, wall squats, lunges, and step ups. The intensity of these exercises was progressed per subject's tolerance.

Hip strengthening was emphasized in this subject's plan of care since balanced hip strength has been shown to play an important role in PFPS prevention¹. Research has shown that instability of the pelvis and hips can lead to a person developing a compensatory anterior pelvic tilt internal rotation of the femur. These factors lead to increased valgus forces on the knee¹.

Patellar taping was provided during 9th and 10th treatment in order to provide proprioceptive feedback at the patella (Kinesiotape Y strip for mild correction of lateral tracking)⁷. Although there were minimal signs of patellar maltracking at this point in the subject's progress, the subject continued to fear that her patella was going to sublux during higher level quadriceps activation. The Kinesiotape allowed the subject to perform squatting and lunging without fear of patellar subluxation¹⁰. While research is inconclusive, studies report that Kinesiotape has been shown to improve proprioception by normalizing muscle tone, reducing pain, correcting inappropriate knee position, and providing stimulation to the skin receptors⁷.

Patient education was provided for this subject in order for her to gain confidence¹⁰. One area of emphasis (with and without the use of Kinesiotape) was the use of body mechanics training during home and work-related activities such as squatting, stairs, and kneeling. Body mechanics training was incorporated into every treatment and was performed within patient tolerance.

Verbal, visual, and tactile cueing was provided to promote improved mechanics of these movements. Addressing body mechanics helped to promote proper knee mechanics of the patella within the trochlear groove¹³. By gradually progressing intensity, the subject was able to perform higher level closed-chain quadriceps activation while promoting proper PFJ mechanics.

The subject was given a home exercise program consisting of stretching and strengthening based on specific deficits determined. She performed these every morning and every evening. For detailed information on home exercise program, see **Table 2**.

OUTCOMES:

At the end of the 6-week intervention, the subject met all short-term and long-term goals. She reported no pain at rest. The subject demonstrated improved gait mechanics on even and uneven surfaces, and reports she was able to perform prolonged ambulation during work and leisure without pain. She demonstrated improved body mechanics with squatting and reported decreased pain with all functional mobility. She demonstrated decreased pain to palpation of the anterior knee, and presented with improved hamstring, quadriceps, and hip strength. The subject demonstrated improvements in knee flexion and extension AROM, and her LEFS score improved by 33 points. For objective data on this criteria see **Table 1**.

DISCUSSION:

The purpose of this case study was to assess the efficacy of Augmented Soft Tissue Mobilization (ASTYM®), in conjunction with standard physical therapy interventions, for the treatment of PFPS. The results of this case description demonstrate the potential effectiveness of ASTYM® treatment in this population. After a 6-week intervention, the subject made a variety of clinically significant improvements. With the use of the numeric pain scale, the subject made a change from 9/10 to 0/10. The NPRS requires a 2 point change to be considered clinically meaningful, demonstrating that this change of 9 points was significant^{11,20}. The subject had significantly less pain to palpation of the patella and anterior knee. It is hypothesized that ASTYM® treatment may have contributed to this decrease in pain provocation. The subject's high pain levels initially limited her tolerance to manual force at the anterior knee. ASTYM® allowed the subject to experience soft tissue mobilization with gentle, rhythmical strokes. This way the therapists were able to appropriately promote the regeneration of dysfunctional tissue without putting the subject through high levels of discomfort. With each ASTYM® treatment, the subject experienced a decreased pain response, and presented with less irregular tissue (noted during ASTYM® treatment). This may be due to increased tissue remodeling (via fibroblasts, growth factors, and phagocytosis) described in ASTYM® literature¹⁶.

It was hypothesized that ASTYM® treatment may have contributed to the subject's AROM gains. ASTYM® may have allowed increased blood flow to the treated area through microscopic capillary leakage, and friction likely warmed the tissue while relaxing the surrounding knee musculature¹⁹. This physiological process, followed by prolonged stretching allowed the tissue to remodel and lengthen along the lines of stress¹⁷.

ASTYM® may have helped to reduce adhesions and improve extensibility of tissues surrounding the knee joint¹⁷. It was hypothesized that improving the quality of these tissues would help to normalize the tensile forces acting on the PFJ¹³. The improvements in patellar tracking (and decrease in degree of patellar tilt) may have contributed in the reduction of PFPS symptoms⁸. Without pain, catching, or locking during knee motions, she was able to tolerate higher level activities; this allowed her to strengthen her hips and knees while improving her body mechanics with functional mobility.

Overall, the subject demonstrated a significant improvement in her perception of disability. Her LEFS score changed from a 12 (demonstrating 82% impaired) to a 45 (demonstrating 43% impaired). She demonstrated a 33-point improvement in her perceptions of functional ability which is significant when noting that the minimal clinically important difference (MCID) of the LEFS has been reported to be 8-9 points in patients with PFPS^{11,21}. The subject noted that she was more aware of her body mechanics, and reported more confidence with high-level activities without fear of re-injury. At discharge, the subject was able to ascend and descend stairs reciprocally, squat without pain, ambulate for greater than 1 hour, sit or stand for greater than 1 hour, kneel without pain, and perform single leg stance for greater than 1 minute.

The subject's GRC improved from 3 points (almost normal) to 4 points (mostly normal). The minimal detectable change for the GRC is 0.45 points, showing that she was able to detect significant improvement²². However, the minimally clinically important difference for the GRC is considered to be 2 points²². Although she did not reach a clinically significant change in GRC score, it is hypothesized that this score would have been significant had she taken the GRC at her initial evaluation (rather than waiting until week 3).

The subject perceived that ASTYM®, body mechanics training (during squats and stairs), and Kinesiotaping were the most beneficial for her recovery. She believed that body mechanics training and tape placement allowed her to "trust the knee." She perceived ASTYM® helped to get rid of the "pulling" sensation that she experienced during passive knee flexion and closed-chain knee extension.

There were a variety of factors present that may have limited the efficacy of this study. First, the GRC was not taken at the initial evaluation, making it difficult to document changes in the subject's perceived progress. Second, with multiple interventions it is impossible to determine if ASTYM® alone lead to changes in the subject's symptoms. Third, some of the changes noted over the 6-week period could have been due to the subject's natural healing process at the knee.

Another factor that limited the reliability of this data was that two different therapists performed treatments and evaluations on this subject, which limited the reliability of this data and could have led to inconsistencies between treatment interventions. ASTYM® however was provided by the same therapist on every visit. This study had a limited sample size, and no blinding or controls were present for this case report.

The use of ASTYM® was predicted to improve tissue extensibility to improve patellar tracking, reduce the degree of patellar tilting, and reduce excessive forces on the underside of the patella. ASTYM® may have played a role in the reduction of hamstring tightness, gastrocnemius tightness, quadriceps tightness, iliotibial band tightness, fibrous capsule adhesions, retinaculum tightness, patellar tilting, and patellar maltracking^{3,10,11,12,13}. Additional research needs to be performed using a larger sample size, randomization, and blinding in order to assess the role of instrument-assisted soft tissue mobilization (specifically ASTYM®) in the treatment of PFPS.

CONCLUSION:

Reducing excess tensile load on the connective tissue surrounding the knee may play an important role in physical therapy practice for normalizing PFJ biomechanics. By using soft tissue mobilization in conjunction with flexibility training, the subject may gain extensibility of tissues that are placing excessive stress upon the patella. Most physical therapy interventions focus on closed-chain quadriceps strengthening for the treatment of PFPS, however they often overlook the initial use of soft tissue mobilization and flexibility training to correct patellar maltracking and reduce PFJ stresses^{1,2,9}. Once there is a normalization of the patellar biomechanics, the PT plan of care can gradually progress strengthening³⁰. The use of ASTYM® for this particular subject may have helped to improve tissue extensibility in order to reduce PFJ forces that were causing anterior knee pain, which allowed her to progress to higher-level activity more quickly. A comprehensive treatment approach (focused on treating the underlying causes of PFPS) allowed this subject to progress quickly and make gains in strength, pain-free motion, body mechanics, and confidence so she could return to her roles at work, home, and leisure.

Table 1: Examination Data

	Initial Evaluation	6th visit (re-evaluation)	Discharge
Pain (at rest)	9/10	5/10	0/10
Pain (with squatting)	9/10	7/10	0/10
LEFS	14 (82% impaired)	24 (70% impaired)	45 (43% impaired)
GRC	Not tested	3/5 (somewhat better)	4/5 (almost normal)
AROM	4-119 degrees	0-136 degrees	0-141 degrees
Quad Strength	3-/5	5/5	5/5
Hamstring Strength	3/5	4+/5	5/5
Hip Flexor Strength	4-/5	4+/5	4+/5
Hip Abductor Strength	4-/5	Not tested	4+/5
Hip ER Strength	4-/5	Not tested	4+/5
Hip IR Strength	3+/5	Not tested	4+/5

Table 2: Home Exercise Program

Exercise	Parameters	Date provided
Quad sets	1x10 (with 5 second hold)	Initial visit
Supine heel slides	1x10 (with 5 second hold)	Initial visit
Straight leg raise	1x10 (with 5 second hold)	Initial visit
Seated hamstring stretch	3x30 sec	Initial visit
Standing gastrocnemius stretch	3x30 sec	Initial visit
Cryotherapy	20 minutes (after HEP)	Initial visit
Forward step ups	1x10 on 6in step	2 weeks after initial visit
Lateral step ups	1x10 on 6in step	2 weeks after initial visit
Sit-to-stand transfers	1x10	4 weeks after initial visit
Standing band-resisted hip flexion	1x1 minute bilaterally	Discharge
Standing band-resisted hip extension	1x1 minute bilaterally	Discharge
Standing band-resisted hip abduction	1x1 minute bilaterally	Discharge

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